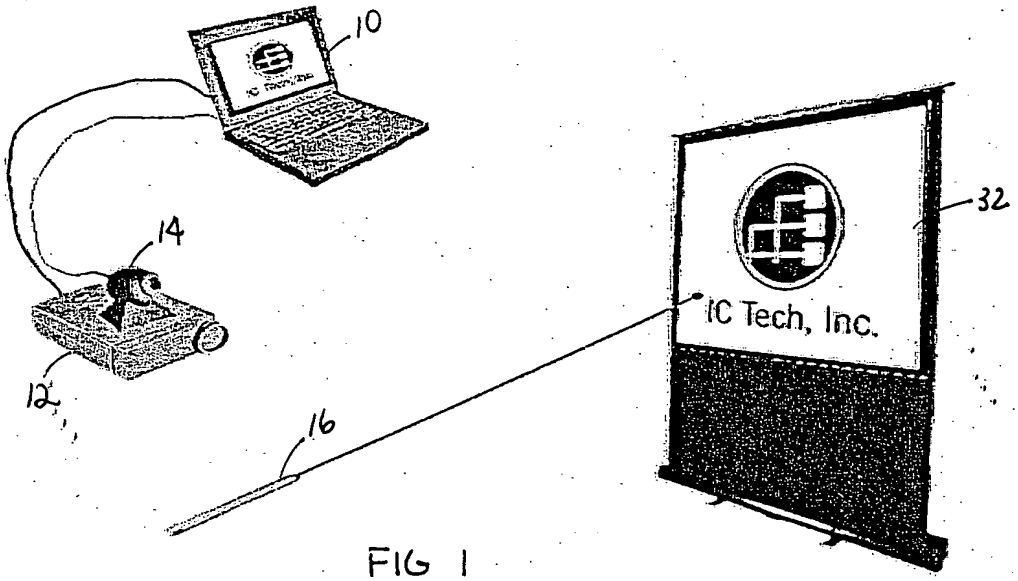



FIG 1

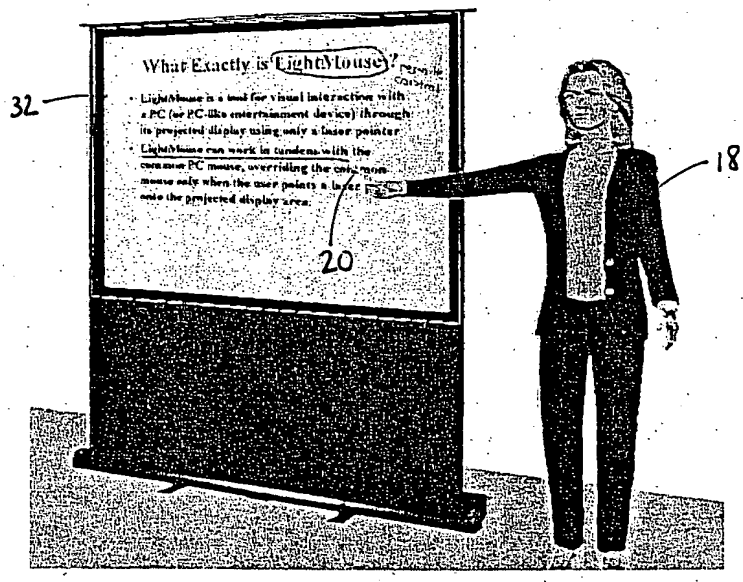



FIG 2

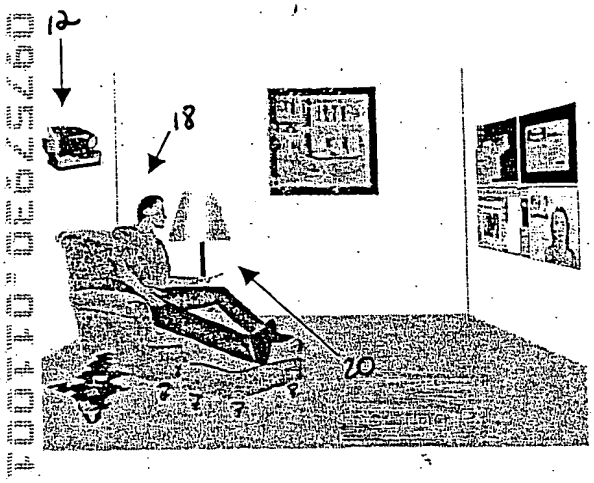



FIG 3

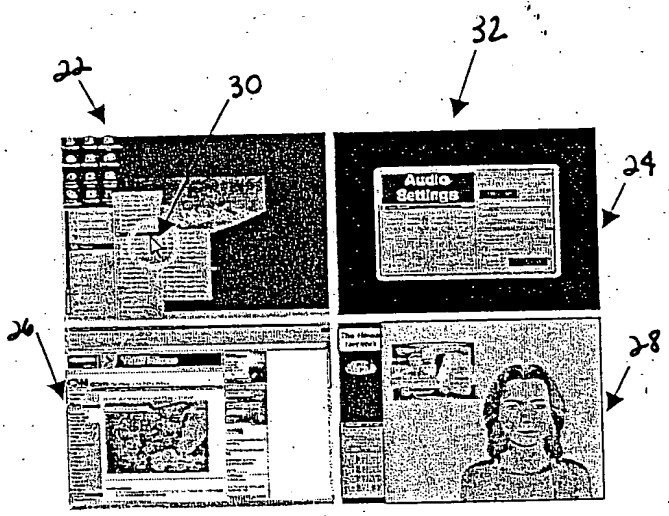



FIG 3a

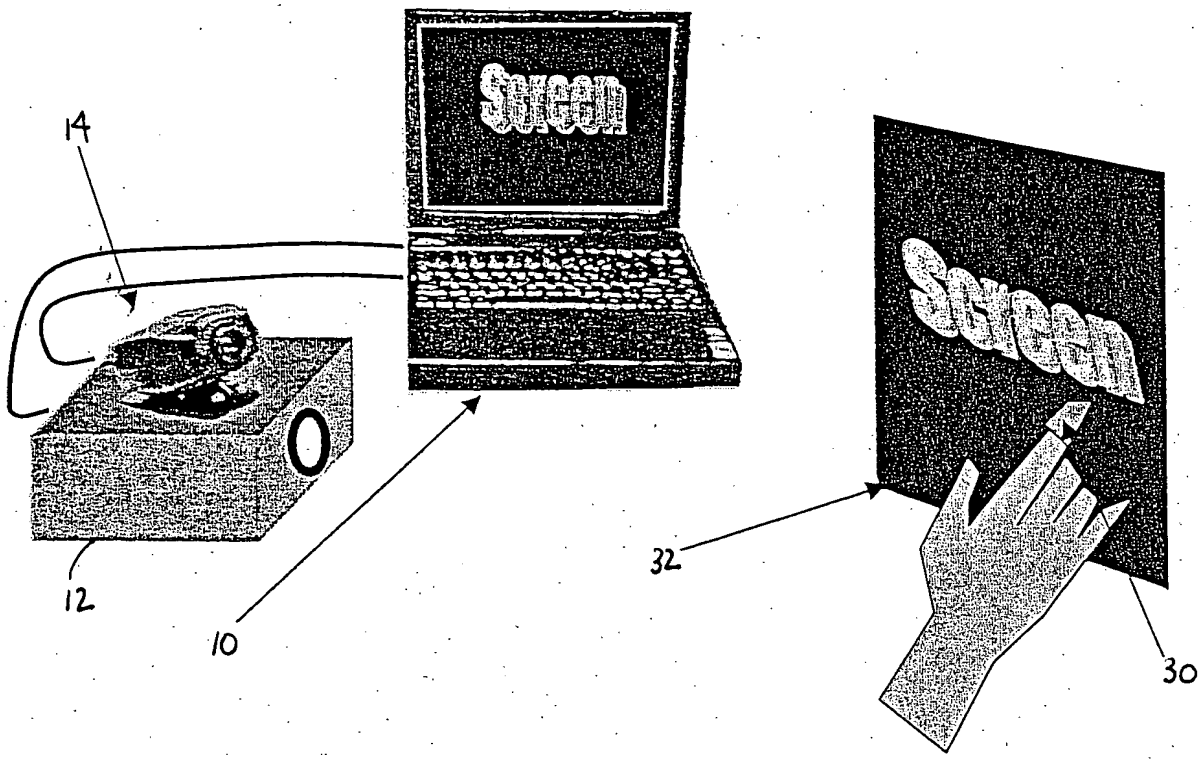



FIG 4

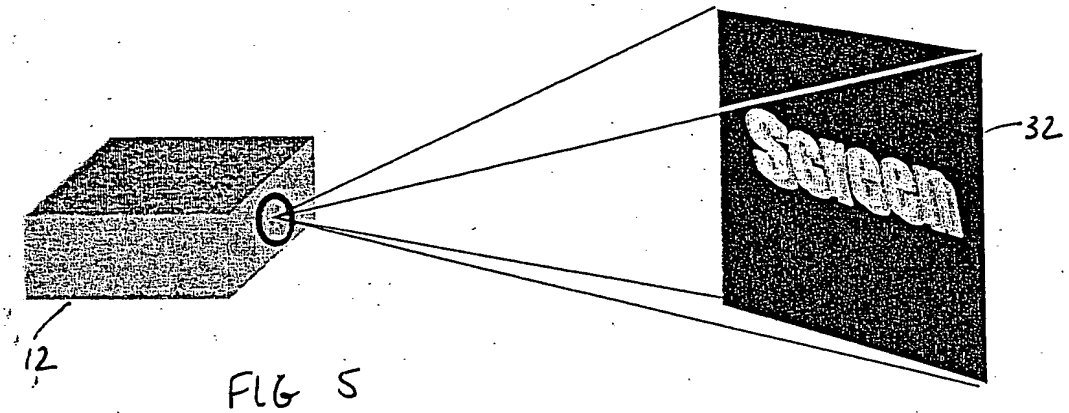



FIG 5

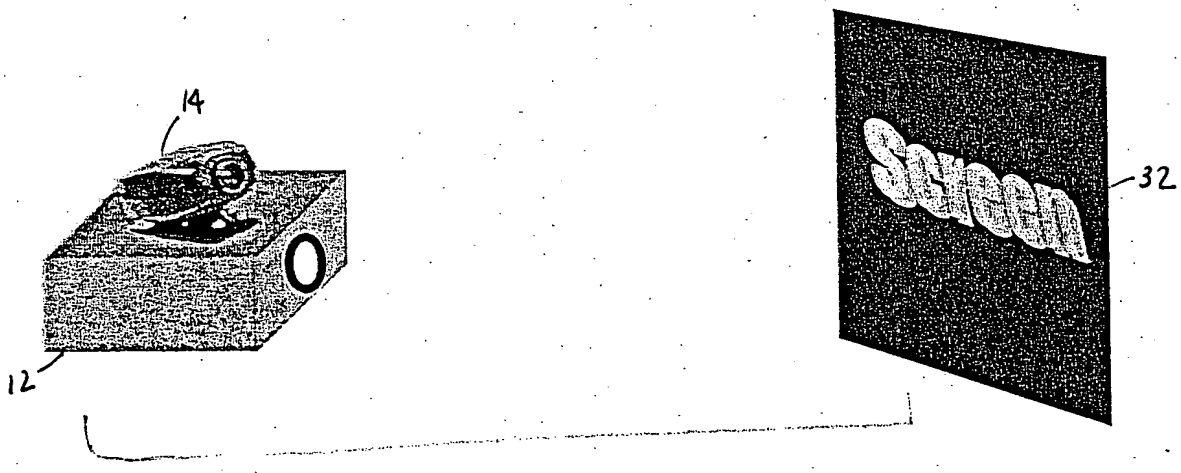



FIG 6

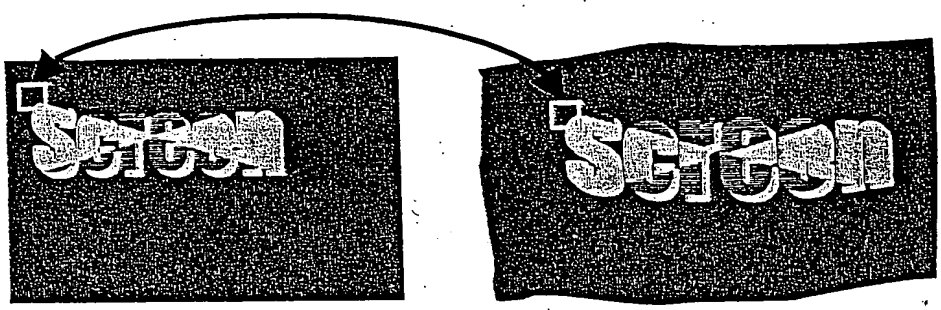


FIG 7

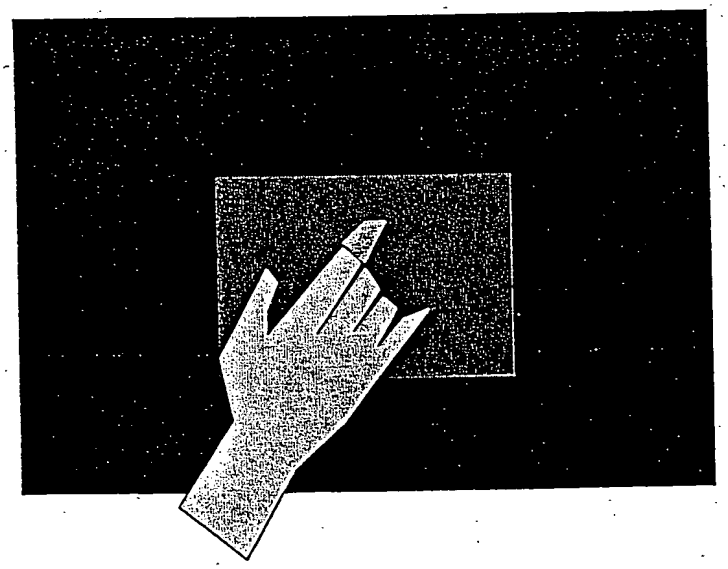


FIG 8

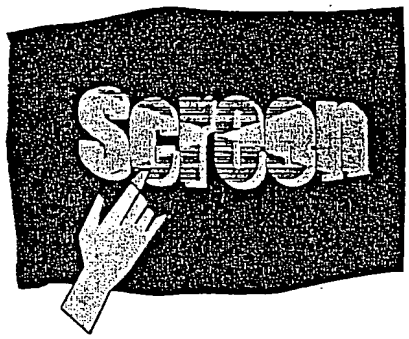



FIG 9

FIG 10

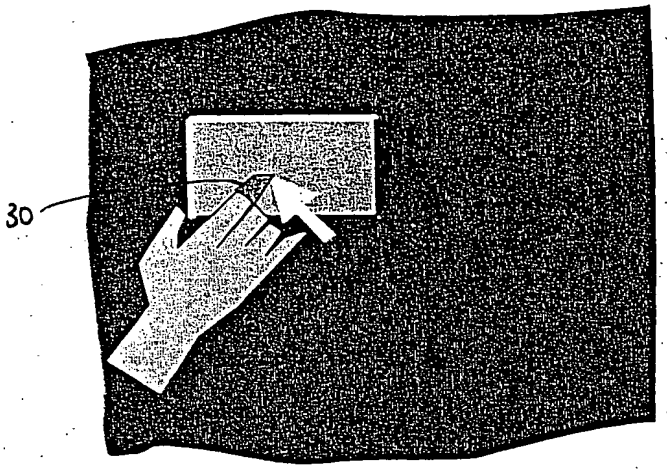



FIG 11

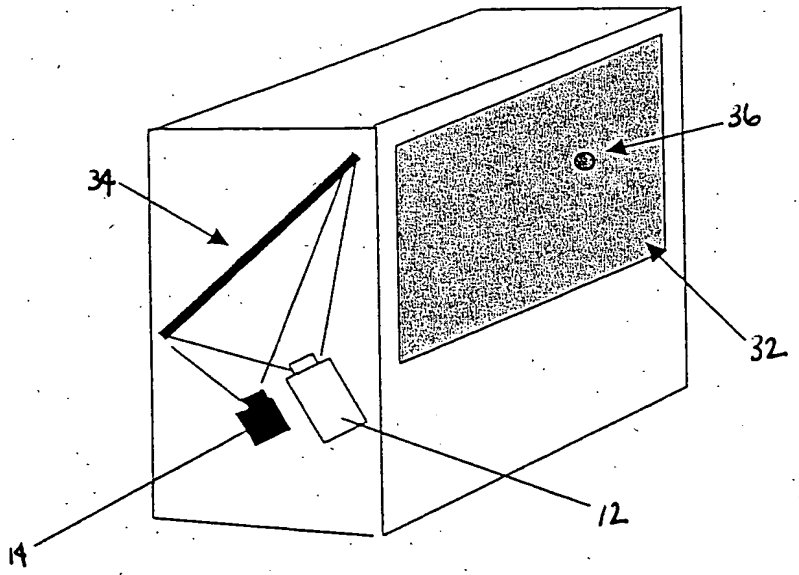



FIG 12

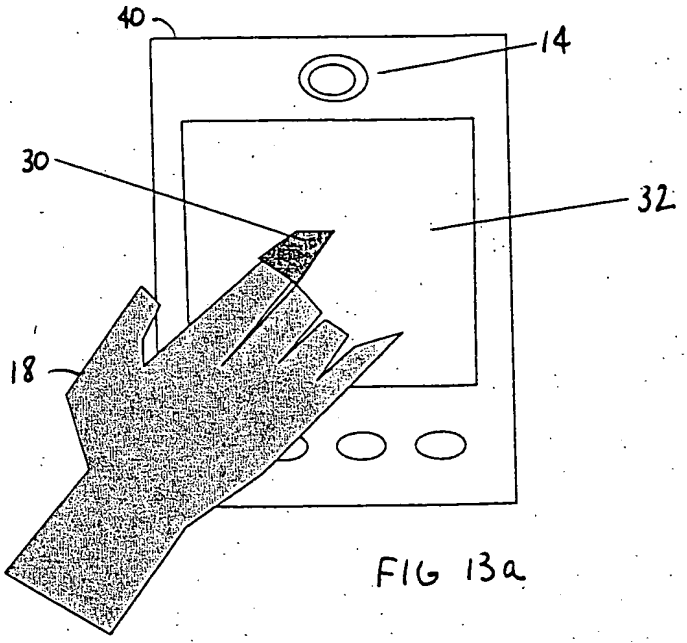



FIG 13a

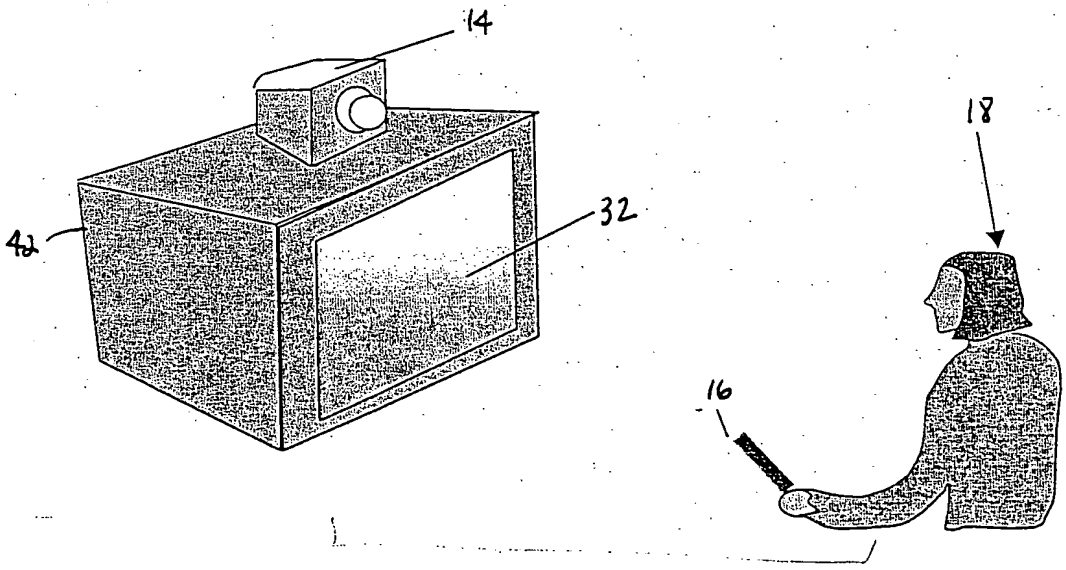



FIG 13b

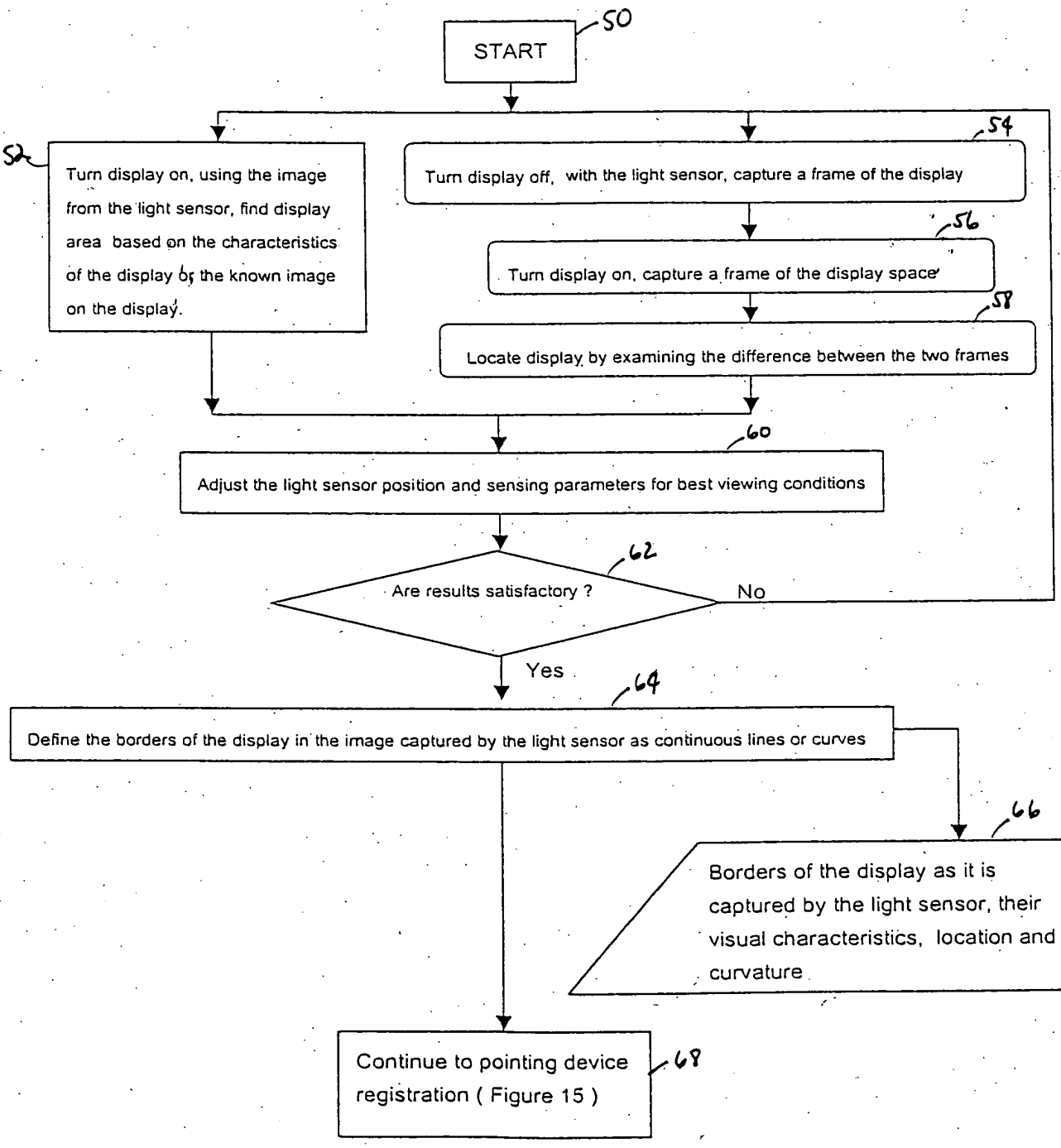

START
50
Turn display on, using the image from the light sensor, find display area based on the characteristics of the display or the known image on the display.
52
Turn display off, with the light sensor, capture a frame of the display
54
Turn display on, capture a frame of the display space
56
Locate display by examining the difference between the two frames
58
Adjust the light sensor position and sensing parameters for best viewing conditions
60
Are results satisfactory ?
62
No
Yes
Define the borders of the display in the image captured by the light sensor as continuous lines or curves
64
Borders of the display as it is captured by the light sensor, their visual characteristics, location and curvature
66
Continue to pointing device registration ( Figure 15 )
68

FIG 14

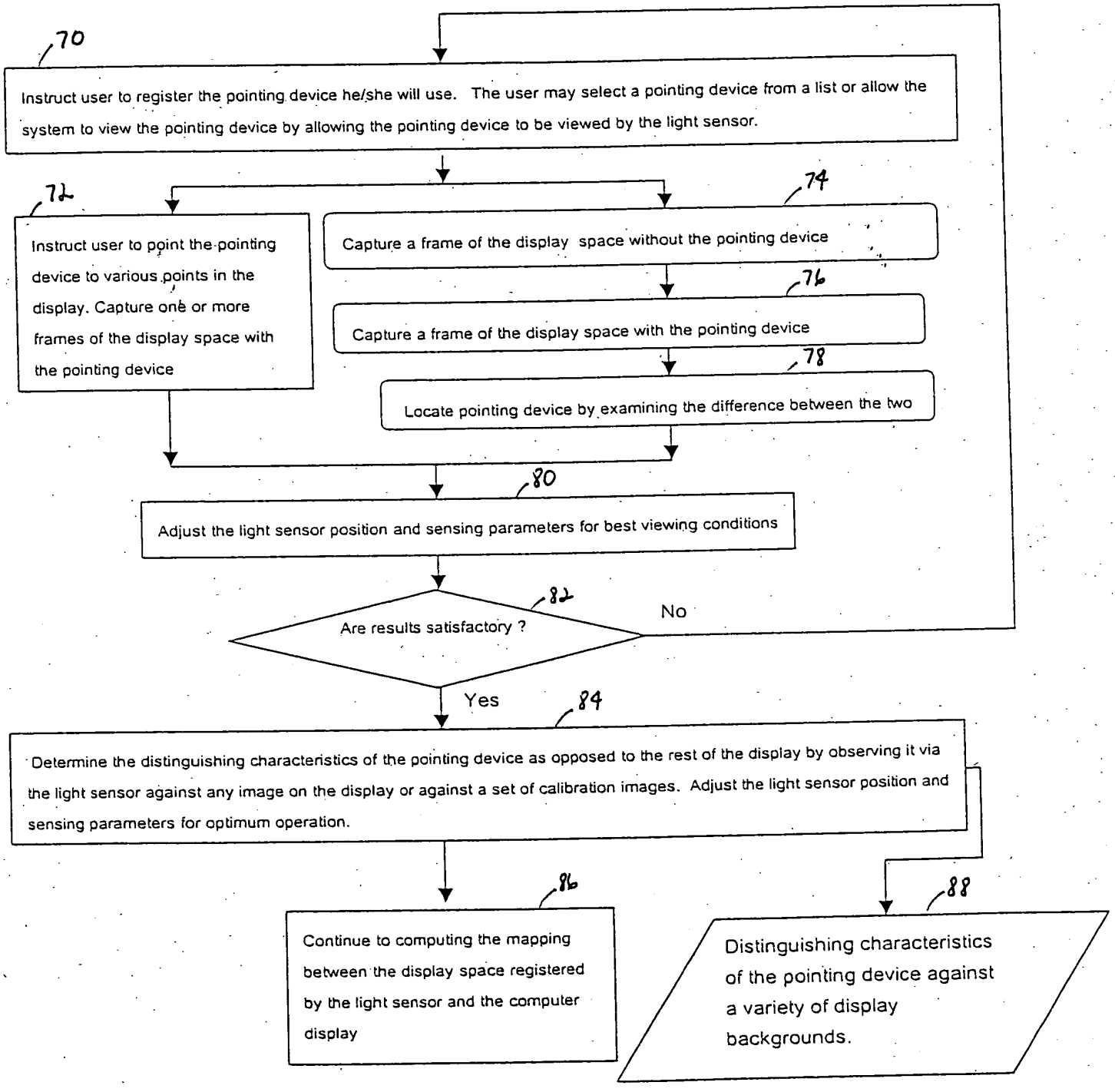

70
Instruct user to register the pointing device he/she will use. The user may select a pointing device from a list or allow the system to view the pointing device by allowing the pointing device to be viewed by the light sensor.
72
Instruct user to point the pointing device to various points in the display. Capture one or more frames of the display space with the pointing device
74
Capture a frame of the display space without the pointing device
76
Capture a frame of the display space with the pointing device
78
Locate pointing device by examining the difference between the two
80
Adjust the light sensor position and sensing parameters for best viewing conditions
82
Are results satisfactory ?
No
Yes
84
Determine the distinguishing characteristics of the pointing device as opposed to the rest of the display by observing it via the light sensor against any image on the display or against a set of calibration images. Adjust the light sensor position and sensing parameters for optimum operation.
86
Continue to computing the mapping between the display space registered by the light sensor and the computer display
88
Distinguishing characteristics of the pointing device against a variety of display backgrounds.

FIG 15

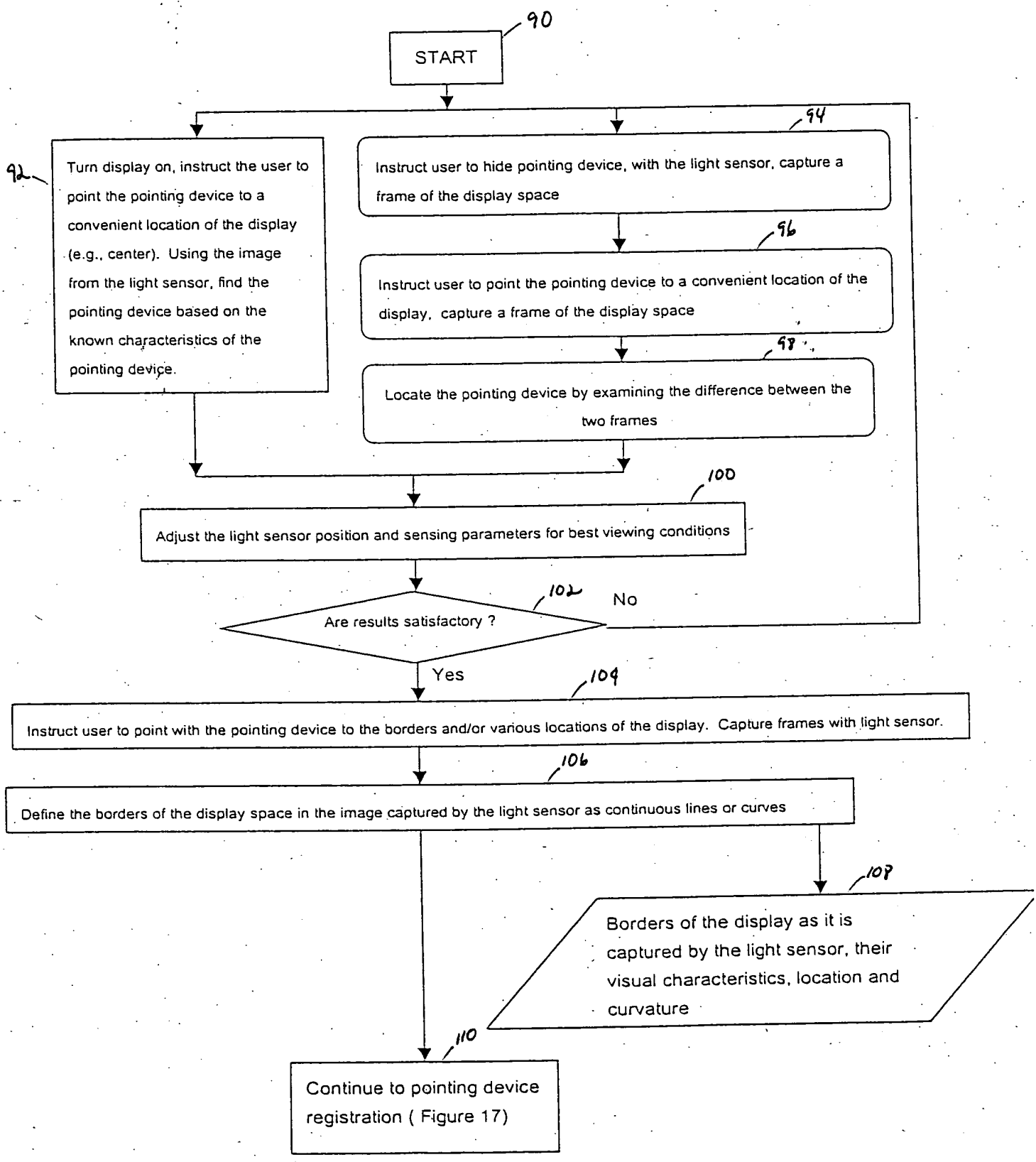

90
START
92
Turn display on, instruct the user to point the pointing device to a convenient location of the display (e.g., center). Using the image from the light sensor, find the pointing device based on the known characteristics of the pointing device.
94
Instruct user to hide pointing device, with the light sensor, capture a frame of the display space
96
Instruct user to point the pointing device to a convenient location of the display, capture a frame of the display space
98
Locate the pointing device by examining the difference between the two frames
100
Adjust the light sensor position and sensing parameters for best viewing conditions
102
Are results satisfactory ?
No
Yes
104
Instruct user to point with the pointing device to the borders and/or various locations of the display. Capture frames with light sensor.
106
Define the borders of the display space in the image captured by the light sensor as continuous lines or curves
108
Borders of the display as it is captured by the light sensor, their visual characteristics, location and curvature
110
Continue to pointing device registration ( Figure 17)

FIG 16

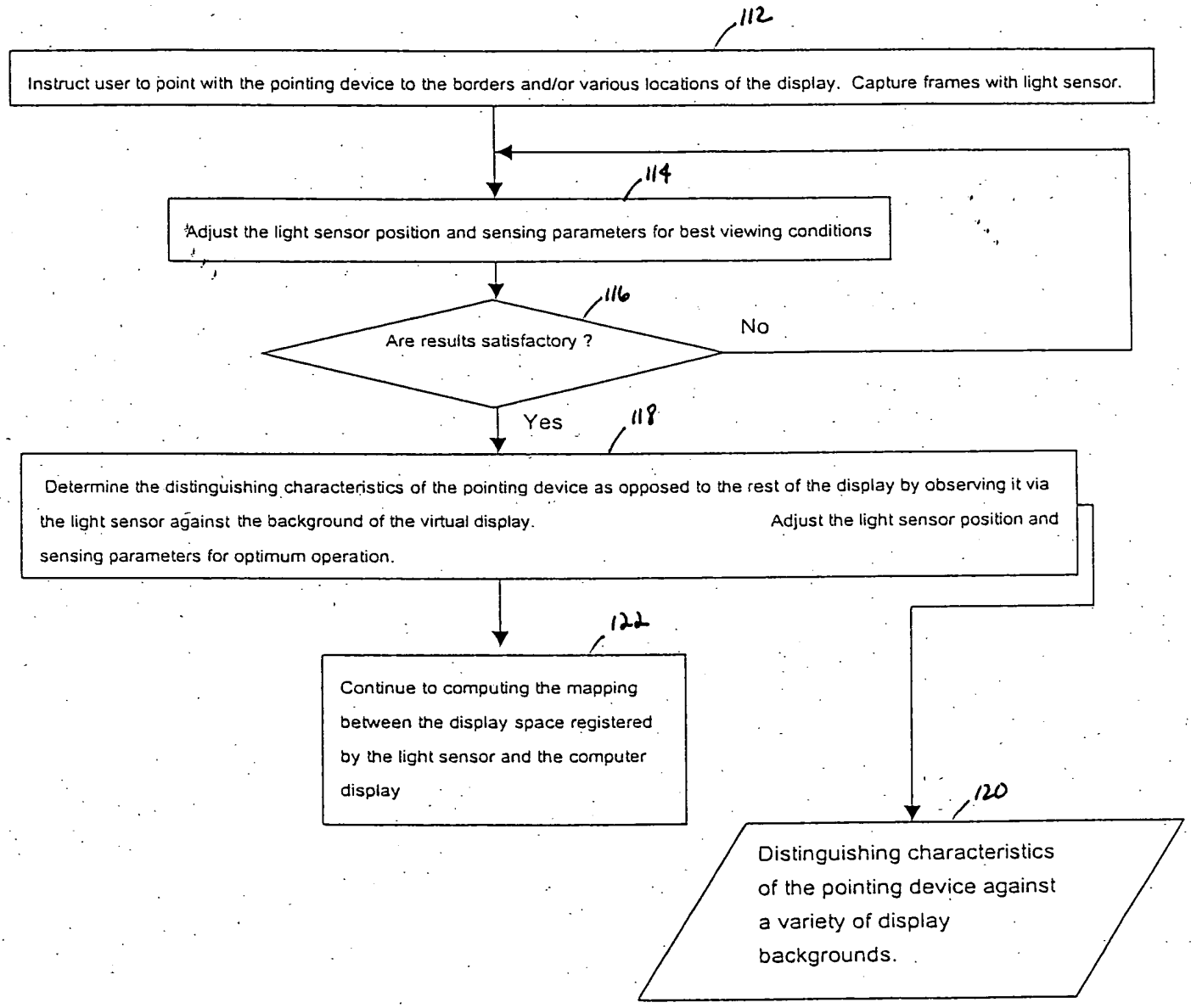

112
Instruct user to point with the pointing device to the borders and/or various locations of the display. Capture frames with light sensor.
114
Adjust the light sensor position and sensing parameters for best viewing conditions
116
Are results satisfactory ?
No
Yes
118
Determine the distinguishing characteristics of the pointing device as opposed to the rest of the display by observing it via the light sensor against the background of the virtual display. Adjust the light sensor position and sensing parameters for optimum operation.
122
Continue to computing the mapping between the display space registered by the light sensor and the computer display
120
Distinguishing characteristics of the pointing device against a variety of display backgrounds.

FIG 17

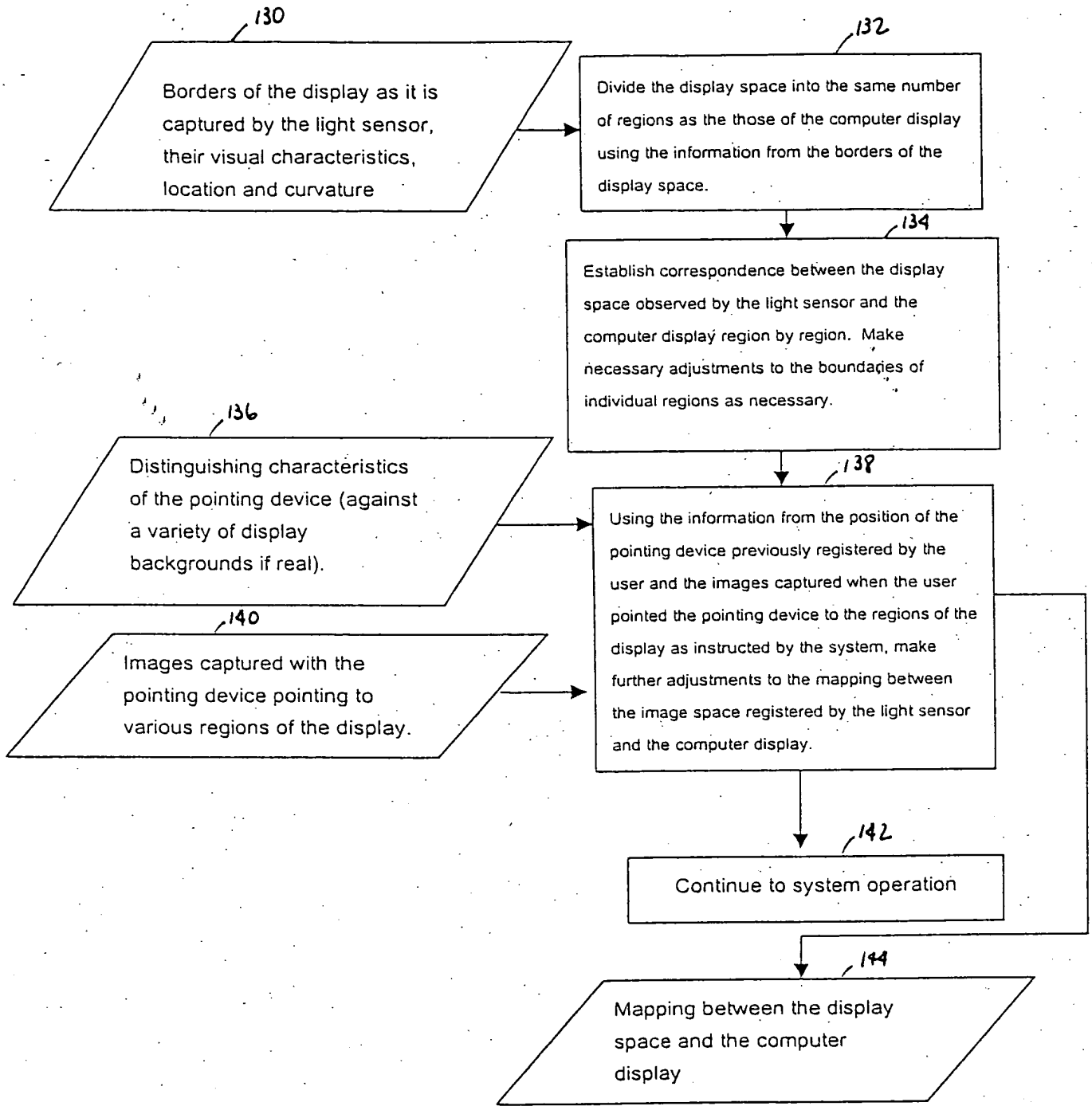

130
Borders of the display as it is captured by the light sensor, their visual characteristics, location and curvature
132
Divide the display space into the same number of regions as the those of the computer display using the information from the borders of the display space.
134
Establish correspondence between the display space observed by the light sensor and the computer display region by region. Make necessary adjustments to the boundaries of individual regions as necessary.
136
Distinguishing characteristics of the pointing device (against a variety of display backgrounds if real).
138
Using the information from the position of the pointing device previously registered by the user and the images captured when the user pointed the pointing device to the regions of the display as instructed by the system, make further adjustments to the mapping between the image space registered by the light sensor and the computer display.
140
Images captured with the pointing device pointing to various regions of the display.
142
Continue to system operation
144
Mapping between the display space and the computer display

FIG 18

FIG 19a

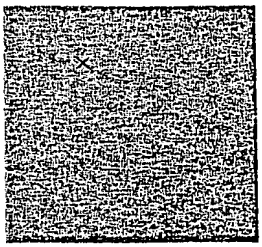


FIG 19b

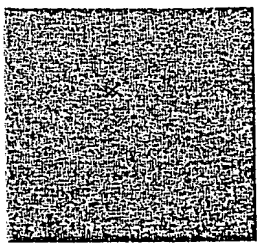


FIG 19c

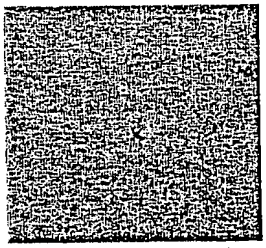
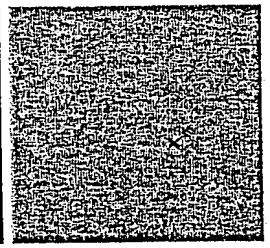


FIG 19d



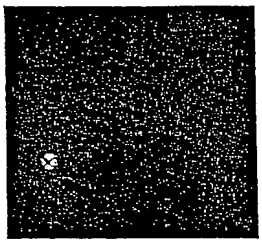


FIG 19e

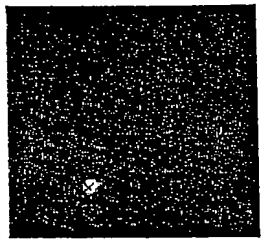


FIG 19f

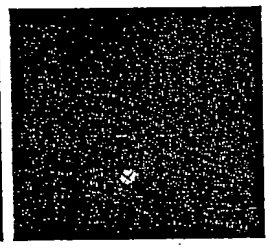


FIG 19g

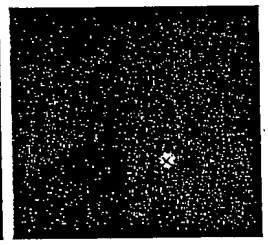


FIG 19h

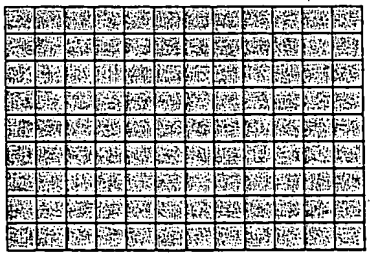


FIG 20a

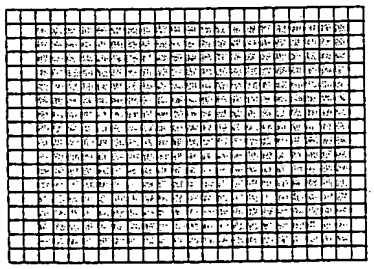


FIG 20b

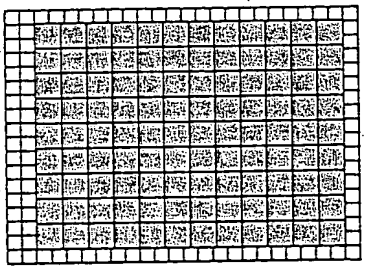


FIG 20c

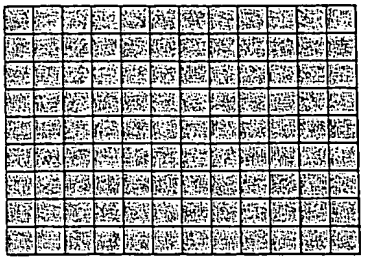


FIG 21a

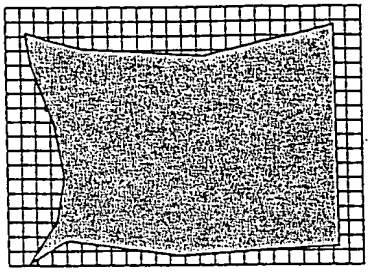


FIG 21b

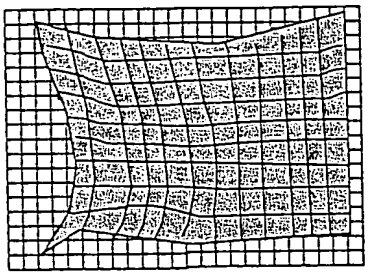


FIG 21c

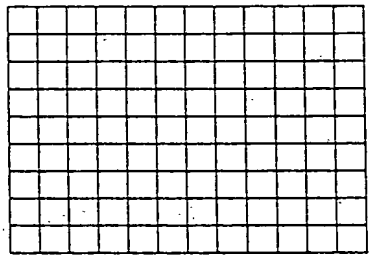


FIG 22a

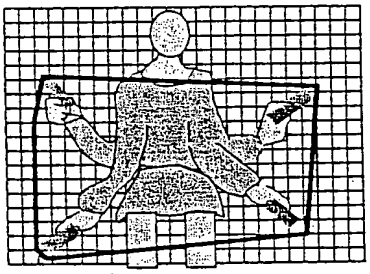


FIG 22b

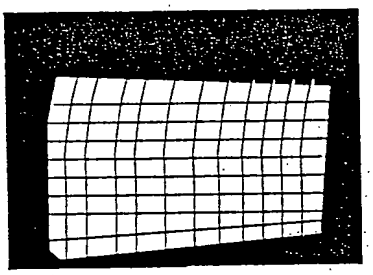


FIG 22c

PAGE BLANK (USPTO)

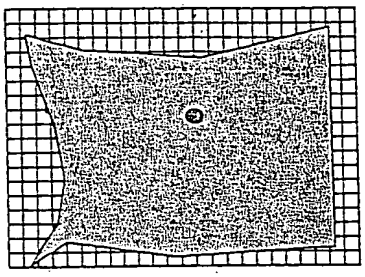


FIG 23a

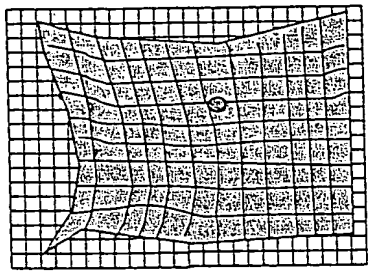


FIG 23b

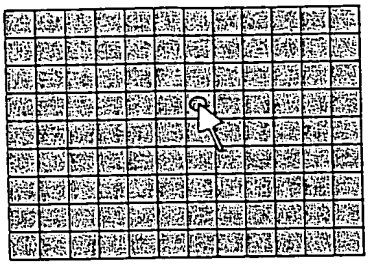


FIG 23c

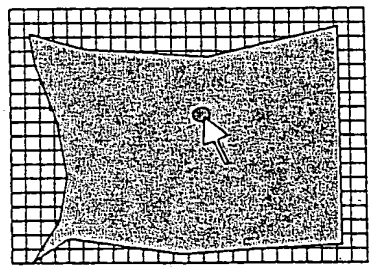


FIG 24a

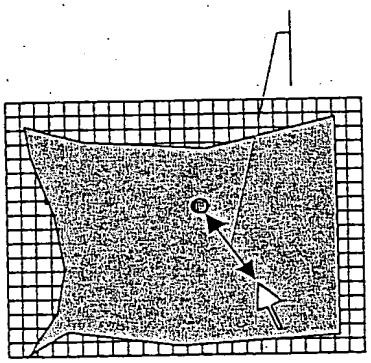


FIG 24b

FIG 25a

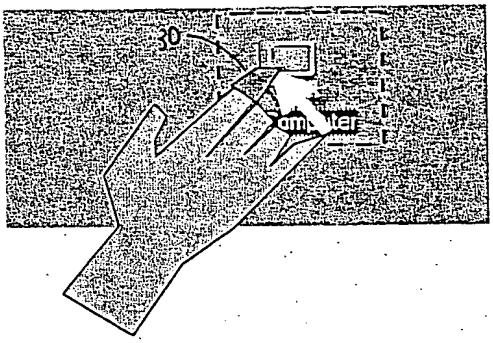



FIG 25b

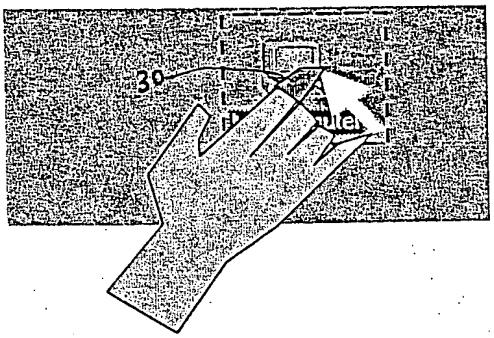



FIG 25c

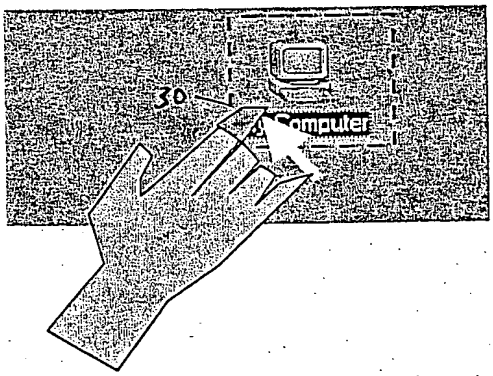
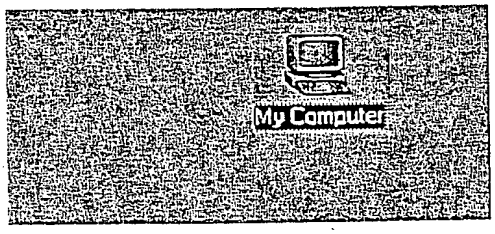



FIG 25d



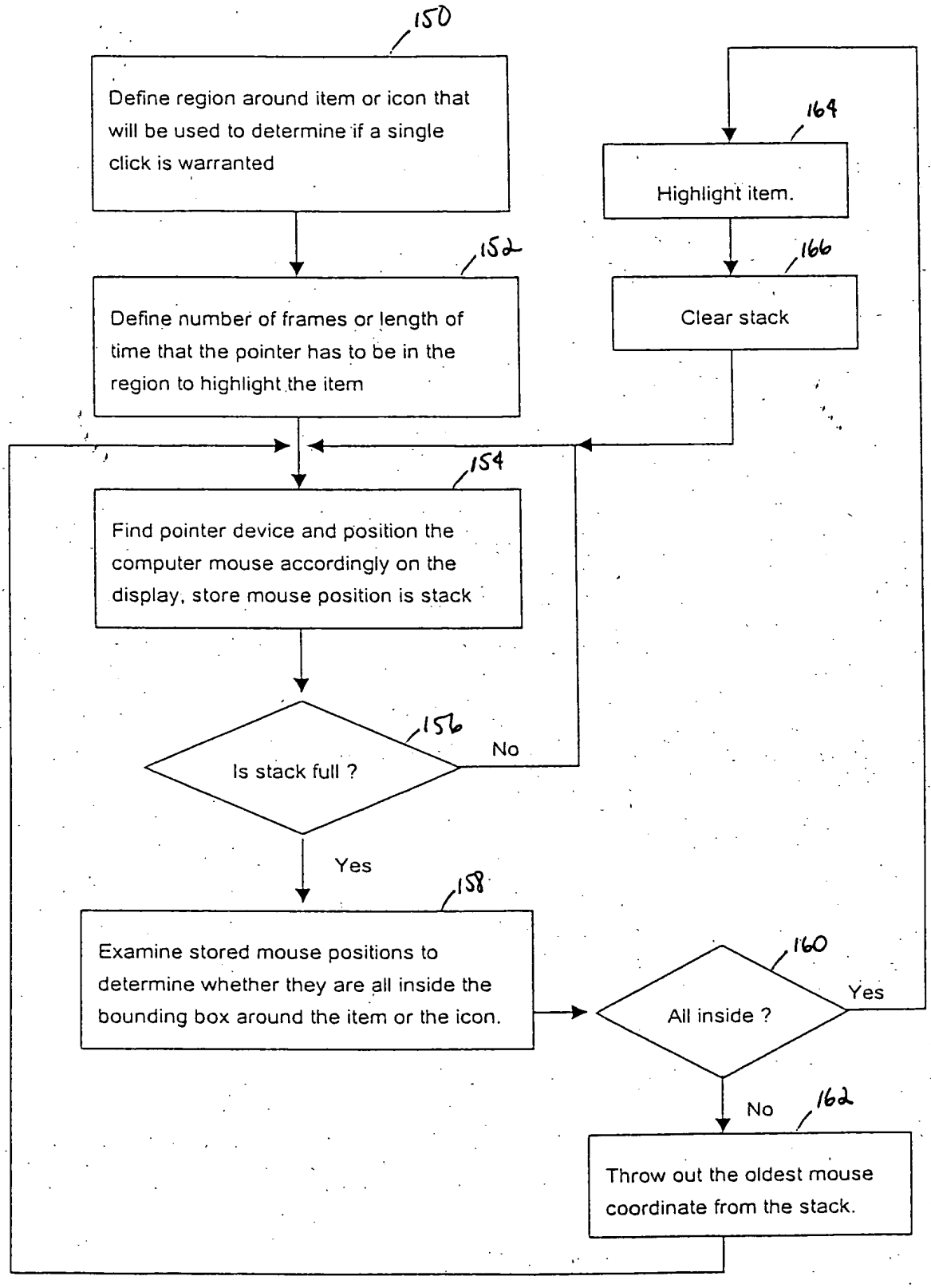

150
Define region around item or icon that will be used to determine if a single click is warranted
152
Define number of frames or length of time that the pointer has to be in the region to highlight the item
154
Find pointer device and position the computer mouse accordingly on the display, store mouse position is stack
156
Is stack full ?
No
Yes
158
Examine stored mouse positions to determine whether they are all inside the bounding box around the item or the icon.
160
All inside ?
Yes
No
162
Throw out the oldest mouse coordinate from the stack.
164
Highlight item.
166
Clear stack

FIG 26

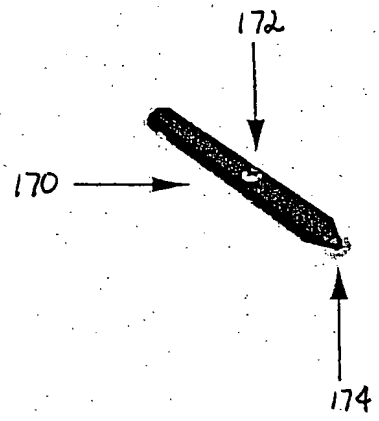



FIG 27

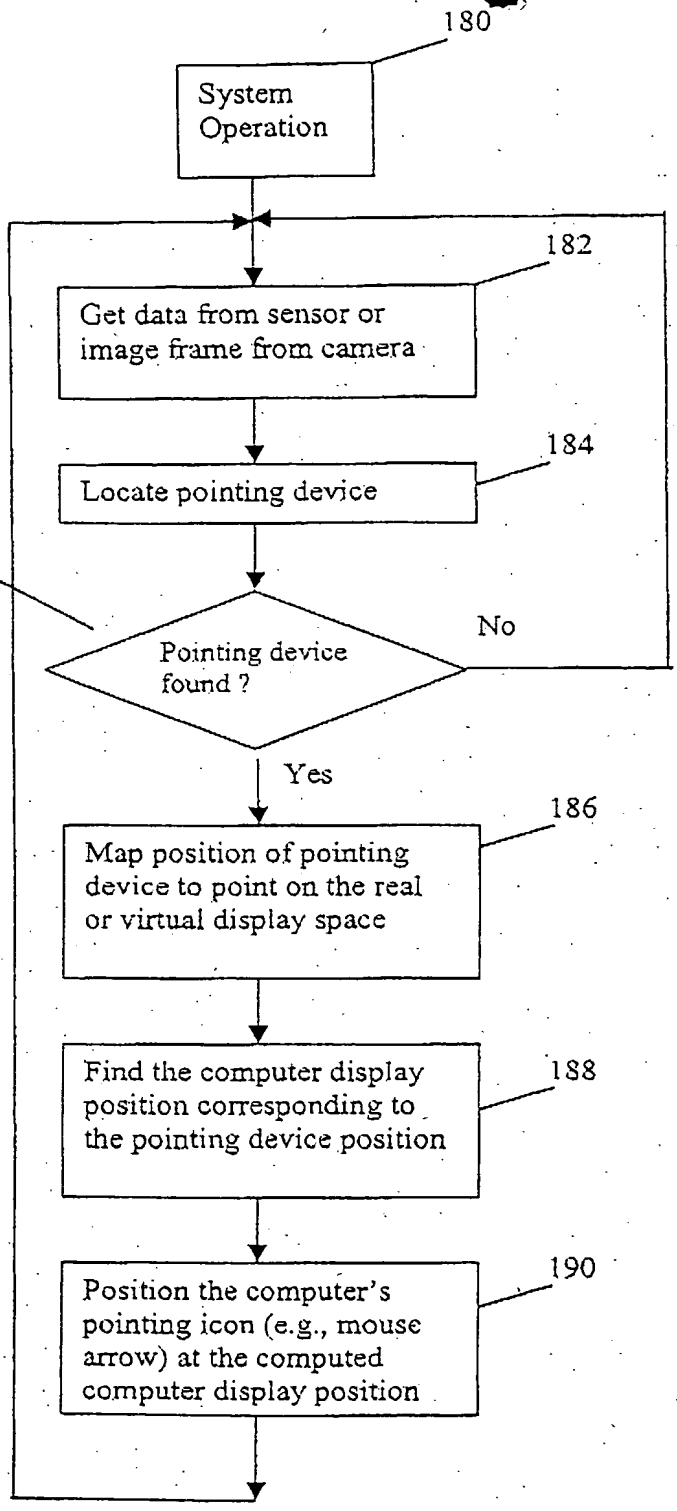

180
System Operation
182
Get data from sensor or image frame from camera
184
Locate pointing device
185
Pointing device found ?
No
Yes
186
Map position of pointing device to point on the real or virtual display space
188
Find the computer display position corresponding to the pointing device position
190
Position the computer's pointing icon (e.g., mouse arrow) at the computed computer display position

FIG 28